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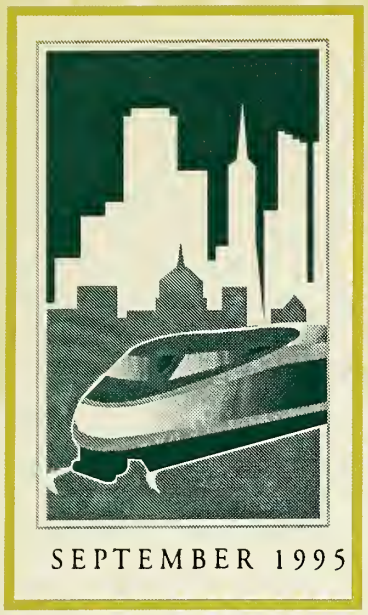

SEPTEMBER 1995

CALTRAIN SAN FRANCISCO
DOWNTOWN EXTENSION PROJECT
CONCEPTUAL DESIGN AND DRAFT EIS/EIR

Transbay Terminal Reconfiguration Structural Analysis Report

PENINSULA CORRIDOR JOINT POWERS BOARD

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1. EXECUTIVE SUMMARY

1.1 INTRODUCTION

The purpose of this Transbay Terminal structural analysis is to identify the added structural capacity needed to convert the existing bus platform deck, originally built as a train terminal, back to a train station and to construct a new bus deck above the new train station. In addition, a seismic analysis of the mezzanine, first floor and basement levels was carried out to identify the retrofit needed to meet current building code requirements.

The original structure "as built" plans were prepared in February 1939. A seismic evaluation study was prepared for the Office of the State Architect by A.C. Martin & Associates in June 1992. Three additional supplements to this report were prepared in December 1992. These three supplements define the present interim seismic retrofit program. This program, at an approximate cost of $4 million, consists of the removal of the concrete roof structure and replacement with 24 gauge, metal roof panels and fiberglass skylight panels; the placement of shear walls or braced frames on each level of the building; and the application of various alternatives for structural steel braces on the Terminal bus deck. The program is designed to minimize potential seismic damage resulting from minor to moderate earthquakes during the interim period prior to a final, comprehensive seismic strengthening. A full strength seismic retrofit (for the existing structure without a new train station), as proposed by the A.C. Martin & Associates report of June 1992, would range in cost from $12 to $18 million. It is not included in the State Architect's current funding recommendation for interim projects.

1.2 METHOD OF ANALYSIS

For this study, the gravity load design for the new train station was developed in accordance with the American Railway Engineers Association (AREA) 1992 edition. The gravity load design for the new bus deck was developed in accordance with the latest edition of Caltrans Bridge Design Specifications. The seismic load design was developed in accordance with the 1994 Uniform Building Code requirements for an essential building and includes two tracks of train load as part of the dead load for seismic analysis. The train load used was two 140-ton locomotives, each with ten 73 ton cars, representing a total track load of 1,010 tons. The preliminary seismic analysis in this study was done using a combination of hand calculations and a simplified lateral force analysis utilizing the computer program RISA2D. The analysis takes into account all the added dead loads imposed by the new bus deck and train station.

1.3 STRUCTURAL REQUIREMENTS

New construction at the top levels of the terminal was assumed to be in structural steel to keep the added dead load to a minimum. A light steel frame with metal decking was chosen for the roof over the new bus deck. Steel columns, framed with steel bents at

approximately 25 foot centers in the east/west direction, and a metal decking with six inches of concrete topping was chosen for the new bus deck. At the station track level, the existing reinforced concrete members were assumed to be strengthened by adding twelve inches to the top of all beams parallel to the tracks, adding six inches of concrete to the slab under the tracks, and increasing all the transverse beams under the new bus level columns from 12" x 24" to 48" x 48". The lower floors of the existing structure would require seismic retrofit (in addition to that recommended by A.C. Martin & Associates) consisting of a significant number of 8-inch concrete shear walls on the mezzanine, first and basement levels plus an 8-inch reinforced concrete slab on top of the entire basement floor to act as a diaphragm connection between all of the pile groups.

1.4 CONCLUSIONS

The results of this structural analysis of the Transbay Terminal showed that the structure could be strengthened to take a new bus deck plus a train station and conform to the seismic provisions of the latest Uniform Building Code. However, such a strengthening would introduce a number of significant issues.

- The bus terminal operations would most likely have to be relocated during construction.
- The parking garage would have to be closed during construction.
- Following the retrofit, the parking garage capacity would be reduced because the new shear wall system would block off some areas and restrict movement in others.
- Following the retrofit, the commercial and passenger uses of the levels above the parking structure would be restricted because the new shear walls would reduce the maximum size of individual renter units and limit pedestrian/customer flows.
- After a maximum credible earthquake, the building should still be operational, but there would be repairable damages to the shear walls and braces.

If more than two trains are assumed to be at the station during an earthquake, then more shear walls and braced frames would be required. In the event that the ultimate six tracks are simultaneously loaded, extensive bracing would be required. This additional bracing would impede the flow of passengers and restrict the utilization of the retail space and parking garage.

All of these issues need to be put in the context of the cost for making an existing 57-year old building safer compared to the costs of a new, more functional structure.

2. INTRODUCTION

This structural analysis of the Transbay Terminal is part of an overall review of environmental impacts, costs, and benefits associated with alternatives for extending CalTrain from its present northern terminus station at Fourth and Townsend Streets to a new location closer to downtown San Francisco. The purpose of the analysis described in this report is to establish the structural modifications needed to convert the existing Transbay Terminal for use by CalTrain commuter trains on the existing platform level, and commuter and intercity buses on a new level above the train platform level, all in accordance with current building and seismic codes.

2.1 EXISTING TERMINAL

The existing Transbay Terminal was constructed in 1938 in conjunction with the San Francisco-Oakland Bay Bridge. The terminal was built for interurban and light rail electric passenger trains. Passenger rail service ended in 1958, and the platform level of the terminal and the approach ramps were converted for use by buses. There have been numerous modifications over the years to the terminal, with the most significant in 1991 when facilities were added at the front of the building for Greyhound Bus service. Following the 1989 Loma Prieta earthquake, Caltrans, the owner of the building, began a program of limited seismic reinforcement. This program and the work performed to date are described in Section 2.2.

The existing terminal is located between Mission and Howard Streets in San Francisco. The terminal building is 164 feet wide. Platforms are 700 feet long and are situated from just west of Beale Street to west of First Street. The section extending east of Fremont Street is called the **east** section; the section between Fremont and First Streets is called the **central** section; and the section extending west of First Street is called the **west** section. The platform level extends through all three sections, crossing over Fremont and First Streets.

The terminal contains four levels. The basement level contains public parking in each of the three separate sections. The street level contains public entrances, police substation, retail shops, and public restrooms in the central section; commercial space, including Greyhound's freight facilities in the east section; and public parking in the west section. The mezzanine level contains public and retail space in the central section, and parking and public ramps in the west section. The fourth level contains the platforms and Greyhound's waiting room and ticket area.

The terminal is part of a continuous elevated loop to and from the San Francisco-Oakland Bay Bridge. Traffic enters the terminal from the east on an elevated roadway which passes south of the terminal and loops around west of Beale Street. Traffic leaves the terminal on the west end on an elevated roadway which turns south toward the Bay Bridge and meets the incoming roadway just south of Folsom Street. In addition to the Bay Bridge, there is vehicular access to the elevated roadways from Second Street just south of Harrison Street.

The terminal is a reinforced concrete structure supported on redwood timber piles. The bridge portions over Fremont and First Streets are steel girders. The original track and platform configuration consisted of six tracks, in pairs of two's, with two center platforms and two side platforms. The structure under the trackways is more heavily reinforced than under the platforms to accommodate the loading of the trains. Similarly, the columns extending below the platform were located to accommodate the train loading. The original terminal roof was supported by steel columns which were located between the pairs of double tracks. When the terminal was converted for buses, these columns were removed, and columns were added on the platforms.

2.2 PRIOR SEISMIC EVALUATIONS

The Transbay Terminal was built in 1938, before any seismic design was required by building codes. Following the 1989 Loma Prieta earthquake, Caltrans , the building owner, asked the Office of the State Architect (OSA) to prepare a seismic upgrade plan for the terminal. OSA prepared the Transbay Transit Terminal Renovation Project, Functional and Space Program. This program provided for a full modern building code renovation, but funds were not available to meet these requirements. OSA then had A.C. Martin & Associates prepare a seismic evaluation of the terminal buildings. This project was for a full seismic retrofit. Funding of the recommendations of this report was not included in the State Architects funding recommendations for interim projects.

The OSA further requested A.C. Martin & Associates to supplement their report with recommendations for an interim seismic upgrade designed to minimize the building's potential seismic damages resulting from minor to moderate earthquakes. Such a program would be designed to occur prior to the final seismic strengthening recommended in the original seismic evaluation.

A summary of these reports follows.

- Office of the State Architect, Transbay Transit Terminal Renovation Project, Functional and Space Program, April 1992

The primary purpose of this report was to establish a guideline of program definitions and refine the scope of work for future design. This project encompassed a total code renovation meeting all current building codes. Cost estimates were developed with an approximate cost of $63 million to complete the total program. Funds were not available to meet these requirements.

The Executive Summary of this report states that, "if funding were available, the best interest of the public would be served by demolition of the existing facility and its replacement with a new terminal." pg. E3.

- A.C. Martin, Seismic Evaluation of Transbay Terminal

The primary goal of this seismic evaluation was to determine: (1) potential life safety hazards, (2) expected damage levels, and (3) deficiencies requiring remedial strengthening.

Based on performance criteria established by Caltrans, the Transbay Terminal must maintain continuous operation during and after a major earthquake. After an evaluation of various available strengthening approaches, three possible strengthening schemes were identified. Cost estimates were developed for each, ranging from approximately $12 million to $18 million. None of these schemes was included in the State Architect's funding recommendations for interim projects.

- A.C Martin, Supplemental Reports No. 1, 2, and 3 to the Seismic Evaluation Report, June 1992:

These reports defined the interim seismic upgrade program. The following major elements are included in this program:

- Removal of the train/bus deck concrete roof and replacement with a 24-gauge metal roof and fiberglass skylight panels. This element has been completed.

- Addition of concrete shear walls on each level of the Terminal buildings. This element has been completed.

- Various alternates for bus deck bracework.

3. METHODOLOGY AND BASIS OF DESIGN FOR THIS EVALUATION

The purpose of this analysis is to identify the structural capacity needed to convert the existing Transbay Terminal bus deck to a train deck and to construct a new bus deck over the train deck.

Two types of analysis were performed. The first analysis was done to determine the elements needed due to **vertical loads**, including:

- Additional structural members needed for the new bus deck and roof,

- Strengthening of the train deck required to carry vertical loads imposed by the new bus deck and roof, and

- Strengthening of the train deck required to carry a 140-ton locomotive.

The second analysis was performed to identify the **lateral seismic design force** and the required elements to carry this force in compliance with the current seismic codes. Major elements of this analysis included:

- Determination of the design lateral loads on the building, include the load from the new bus level,
- Determination of the lateral load capacity of the existing structure,
- Identification of the requirements, number and location of additional concrete shear walls,
- Identification of the requirements, number and location of steel brace frames,
- Verification of the adequacy of the load transfer mechanism through the lateral force path, and
- Verification of the lateral force carrying capacity of the foundation system.

3.1 BASIS OF DESIGN

3.1.1 Base Documents

This analysis was performed primarily using the 1939 "as-built" plans for the construction of the original terminal. These documents were supplemented by the Seismic Evaluation of the Transbay Transit Terminal report prepared for The Office of the State Architect by A.C. Martin & Associates, June 1992, including supplements No. 1, No. 2 and No. 3 in December 1992.

3.1.2 Terminal Concept

The concept analyzed in this study is to convert the Transbay Terminal's existing bus platform level, originally constructed for electric interurban light rail vehicles, back to a train station. Buses would be accommodated on a new third level structure located above the existing platform level. The combined terminal would be extended by 300 feet on its east end across Beale Street up to the Pacific Gateway Building, and then stub-ended. Trains would enter and leave the terminal on a new two-directional elevated ramp from the west, generally following the alignment of the existing elevated westerly ramp structure. South of Howard Street, the CalTrain tracks would descend into a subway below Folsom Street, Harrison Street and the Bay Bridge approach (I-80 Freeway). Buses would also enter and leave the terminal from the west end, on a new structure above the CalTrain tracks. South of Folsom Street, the bus roadway would meet the existing elevated structure and roadways to and from the Bay Bridge. The bus level would have a counter-clockwise turning loop located at the new east end of the terminal.

Due to the 1,000 foot length of platform needed for the trains, a 300-foot long extension of the existing platforms would be needed on the east end. This extension would cross Beale Street and would extend as far as the east side of the old freeway on-ramp located on the east side of Beale Street. The existing bus ramp bridge over Beale Street would

have to be demolished; however, portions of the existing curved elevated structure between Beale Street and the east end of the existing terminal building could be used.

The original terminal was constructed with six tracks. For projected CalTrain service, a minimum of four tracks is needed. Due to structural framing of the original terminal, the original track locations would need to be retained. The concept assumed for this study would use the four original center tracks (tracks 2, 3, 4 & 5) and two center platforms. The two outer platforms would be extended into the spaces originally occupied by tracks 1 and 6. Future increased commuter or inter-city rail trains could possibly be accommodated by removing the platform extensions and constructing tracks 1 and 6 in their original locations.

3.1.3 Design Criteria

Train Loads: Each train is assumed to consist of ten CalTrain commuter cars and two locomotives. A locomotive weight of 140 tons was assumed. This weight corresponds to the weight of an F-59 locomotive and represents the heaviest locomotive that is likely to be used for CalTrain or intercity/high speed rail train service. (The F-40 locomotives presently used for CalTrain weigh 130 tons.) The weight of electric locomotives that could be procured depends on a number of factors, one of which is the maximum, or ruling grade, in the downtown extension. At this point in the study, a grade as high as 3 percent is being considered for the portion of the route approaching the existing Transbay Terminal. Steep grades require heavy locomotives to develop the adhesion, or friction forces, necessary to pull or push the weight of the train up the grade. Therefore, the use of a heavy locomotive for this analysis is appropriate. The impact of a lighter locomotive weight on the results of the study is discussed in Section 4.4

Passenger car weight is assumed to be 73 tons, representing current CalTrain equipment (approximately 60 tons) loaded with 160 passengers. Each train therefore has a total weight of 1,010 tons.

The design of the original Transbay Terminal was based on a rail car weighing 90 tons, which includes an added percent of the live load due to the impact of a moving vehicle. The loads being used for the current analysis cannot be directly compared to the original design loads, as the new locomotives are heavier and the current passenger cars are lighter. In addition, the stresses created by the loads depend on the configuration and spacing of the locomotive and passenger car axles, not just the gross loads, in relation to the specific structural elements. In other words, there is no easy conclusion to be drawn by comparing magnitudes of the loads for original vehicles and those being considered in this analysis.

Bus Loads: Live loading used for the bus platform level was a standard highway design truck load (HS-20).

Structural Criteria: The following codes were used to determine structural criteria:

- 1994 Uniform Building Code (UBC) is used for seismic design criteria. Zone four represents the Bay Area. The Transbay building is classified as an **essential structure**, which allows for high occupancy and/or uninterrupted use in the event of a major earthquake.

- Bridge Design Specification (BDS), State of California is used for the design of the new bus deck.

- Manual for Railway Engineering, American Railway Engineering Association, 1992 edition (A.R.E.A.) is used for the design of the train deck.

The Bridge Design Specifications are used for bridge design, mainly for single level bridges. After the Loma Prieta and Northridge earthquakes, Caltrans abandoned the idea of multi-level bridge structures.

A.R.E.A does not have a requirement for seismic design and specifies that design loads other than train loading be governed by local building codes. Therefore, it seemed appropriate that the Uniform Building Code be used as the general design code, with supplemental requirements from the Bridge Design Specifications (bus loading) and A.R.E.A. (train loading).

3.1.4 Assumptions

The weight of two fully-loaded 10-car trains was included in the loading for the seismic analysis. The implications of additional trains being included in the seismic analysis are discussed in Section 4.4. It should be noted that the Bridge Design Specification would not include trains in the seismic load.

3.1.5 Structural Framing Concept

General: The existing building columns would fail during a major earthquake, because they are not designed to take lateral seismic forces. The introduction of shear walls would provide lateral resistance to seismic forces, reducing the likelihood of column failure. It is not feasible to adequately strengthen the existing beam and column frames to take the seismic forces without using shear walls.

Geometry: The platform deck's existing support columns are located adjacent to the former trackways. One column is located between each pair of former tracks, with adjacent columns spaced about 10 feet on either side. The roof of the terminal was originally supported by columns located between the tracks. These columns were removed when the terminal was converted to bus use. The structural reinforcement of the track and platform slab is heavier underneath the trackways than under the platforms. The original track locations therefore need to be maintained for the conversion of the terminal back to use by trains.

The existing columns have adequate capacity to support the additional **vertical load** of the new bus deck. However, minimum horizontal clearance requirements established by the California Public Utilities Commission (CPUC) for railroads preclude locating the necessary columns to support the new bus deck directly on top of the existing columns.[1] It is therefore necessary to place the new bus deck columns in the platform areas sufficiently offset from the tracks to allow adequate clearance for passengers to stand between the edge of the platform and the column. This situation requires that the beam under the platform slab transfer the vertical load from the new bus deck to the existing columns below the train deck.

Bus Deck: The bus level framing consists of steel ductile moment frames. In the transverse direction, the columns are located according to the criteria as mentioned above. In the longitudinal direction, the column lines are located to coincide with the concrete column lines below the track level. The new bus deck is assumed to consist of heavy-gauge metal decking with six inches of concrete topping between the structural steel beams.

Train Deck: Concrete beams on both sides of the tracks and slabs under the tracks are assumed to be strengthened to take the increased locomotive loads. Concrete beams in the transverse direction are assumed to be strengthened to take the column load from the bus level.

3.2 STRUCTURAL REQUIREMENTS

The following structural requirements are assumed for the building conversion.

3.2.1 Concrete Portion

Track Level Framing: Concrete beams are assumed on each side of the tracks. Twelve inches of concrete with reinforcement would be placed on top of the existing beams. Steel dowels would be used to connect the new with the existing concrete. New steel stirrups would be added to the beam by drilling and epoxy grouting through the existing concrete, and adding six inches of concrete to the soffit of the beam.

Concrete slab under tracks: Six inches of concrete with reinforcement would be added on top of the existing concrete slab. Steel dowels would be used to connect the new with the existing concrete.

Concrete beams in transverse direction: The existing beam would be increased from 12"X 24" to 48"X 48", with added reinforcement and stirrups.

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[1] Horizontal clearances for railroads in California are governed by CPUC General Order 26-D. Although the CalTrain downtown extension will be passenger-only service, the railroad is a conventional railroad and therefore still subject to the rules applicable to freight railroads.

Concrete Shear Walls: Shear walls would be added in various locations. All walls would be 8 inches thick, with #4 reinforcing at 12 inches on center each way, on both faces. Steel dowels, drilling and epoxy grouting would be used with the existing columns, footing or slab at the connections between new and existing concrete.

Foundation slab: Eight inches of concrete with reinforcement would be added to all foundation slabs. Steel dowels would be used to connect the new with the existing concrete.

3.2.2 Steel Portion

Bus level framing: Structural steel (W shapes) is assumed to be used for bus level columns and beams. Metal decking with six inches of concrete topping is assumed to be used for the bus level slab.

Bus level roof: Structural steel (W shape) is assumed for the roof columns. Steel trusses with light gauge metal decking is assumed to be used for the roof framing.

Steel braces at Fremont and First Streets: Additional steel-braced frames between the columns supporting these bridges are assumed.

3.2.3 West Approach Structure

The new approach structure is assumed to be constructed using concrete ductile moment frames conforming to current Caltrans seismic design standards.

3.2.4 East Extension (New Structure)

The new viaduct at the east end of the Transbay Terminal and the bridge across Beale Street are assumed to be reconstructed to make a straight entry to a new viaduct structure to be built on the east side of Beale Street. The new structure would use a similar structural system as in the existing Terminal building.

4. CONCLUSIONS AND CONSIDERATIONS

4.1 SHEAR WALLS AND BRACING REQUIREMENTS

The shear walls proposed in A.C. Martin's' interim seismic upgrade report do not represent a full-scale seismic retrofit, even if the terminal maintains its current usage and is not converted to a bus/ rail facility. The purpose of the interim upgrade is only to reduce the risk of a catastrophic failure in a minor to moderate earthquake.

For a combined bus and train terminal, the added load caused by the trains and new bus level results in significant added seismic loading to the structure, and thus requires more shear walls than the existing structure would.

In general, long shear walls are more desirable than short shear walls. Short shear walls will produce significantly more uplift force which can result in pull-out of the end piles from the foundation. There is a requirement for a minimum total length of shear walls in order to take the seismic forces and prevent this "pull-out." Even though there is some flexibility with regards to the location and configuration of these shear walls, the additional interior walls would require changes to existing terminal operations - i.e., usage of the commercial leasing space and the garage will be restricted.

4.2 FOUNDATIONS

The Transbay Terminal's existing foundation system is supported on redwood timber piles, which have very limited capacity to resist earthquake-generated lateral loads. A thickened slab will be constructed on top of the existing basement slab in conjunction with the construction of the new shear walls. This will effectively tie the existing pile groupings together and allow the lateral loads to be distributed to the number of piles required to resist the loading. The new slab will also increase the foundation vertical load carrying capacity needed for the trains and added bus deck.

4.3 CONSTRUCTION STAGING AND MAINTENANCE OF TRAFFIC

To maintain the use of the terminal during the construction required for a new bus level and a renovated train terminal, the work would have to be carefully staged for each of the three terminal sections separately. One possible approach follows:

Stage 1 -- Construct the **west** section and the **west** half of the middle section. Construction during Stage 1 would include both levels of the west portion of the terminal, as well as the approach ramps for the buses and trains. Service would be maintained on the existing bus platforms at the east end of the terminal. Bus access to and from the platforms on the existing level would be provided on the loop ramp at the east end. Two-way operation would be required. Buses would have to turn around in the middle section of the terminal. This operation would require modification of some of the existing platforms. Lane 1, presently used by Greyhound, and Lane 2 could continue to be used by buses in the present direction. Lane 3 would be used for buses in the opposite direction. The current island platform used by Lane 3 would be on the left-hand side of the buses, so it would not be accessible for boarding. The existing side platform on the south side of Lane 3 could be converted for bus access. The extension of Platform No. 3 west of the terminal would similarly not be accessible. There does not appear to be space available on the loop ramp to construct additional temporary platforms. Thus, it appears that during Phase 1, less than half of the current amount of platform length would be available for bus loading. Access to Greyhound platforms in the west half of the building from its waiting room would not be possible. It may be necessary to close off the waiting room entirely, depending on the extent of the construction.

Stage 2 -- Construct the **east** section and **east** half of the middle section. For construction Stage 2, access to the new bus level in the west half of the terminal constructed in Stage 1 would be via the new two-directional elevated bus ramp. A temporary turnaround for

buses would need to be provided at the east end of the new terminal. It is possible that some temporary platforms could be constructed in the ramp area west of the terminal during Stage 2, but only about half of the ultimate number of platform space could be provided during the Stage 2 construction.

It is questionable whether adequate bus platform space could be provided in either of the first two stages. In addition, Greyhound bus facilities, which are now in the middle section of the terminal, would be significantly restricted and disrupted. Additional passenger access to buses during construction would probably need to be constructed to provide the necessary capacity. Retail and other uses in the middle section would have to be relocated or suspended. Parking in the lower-level garages would have to be suspended during the construction of each terminal section.

Assuming that such staging were acceptable, the additional cost for doing the work in stages would be significant. Many work activities would have to be done at least twice. This means that individual subcontractors and trades would be performing work at two distinct times, separated by months or even years, and the total time to complete the project would be increased.

In addition, the ability to maintain bus access to the terminal from the ramps to and from the Bay Bridge may be difficult, due to geometric constraints and construction requirements near Folsom Street. At this point in the study, it is not clear that adequate bus access to the terminal could be maintained during construction.

In summary, maintaining passenger and bus use of the existing Transbay Terminal during the renovation and re-construction would be difficult, time consuming and costly.

4.4 EFFECTS OF DIFFERENT LOADING

Locomotive weight: 140-ton locomotives have been assumed for this analysis. It is possible, depending on the grade of the tracks approaching the terminal, that lighter locomotives may be suitable. A light locomotive would weigh about 100 tons, so the reduction in live load for each train with lighter locomotives would be about 80 tons, or 8 percent of the total train loading. This reduction would have a minor impact on the shear wall requirements, which are a function of the total loads imposed by the buses, the bus platform structure, the trains plus the train deck. The difference in locomotive weights would equate to less than a 1 percent reduction in total design loading.

Number of trains: Seismic design is based on probability and risk. For this design, it was assumed that the train loading would be two trains comprised of two locomotives and ten passenger cars fully loaded with passengers. Present CalTrain passenger service uses one locomotive and five passenger cars. This would equate to four trains on the tracks to equal the design loading. The assumed loading therefore appears to be reasonable from a risk management point of view. The probability of the assumed loadings being exceeded during a seismic event appears to be minimal.

4.5 OTHER IMPACTS: HOWARD STREET BRIDGE

The Transbay Terminal was constructed in conjunction with the Bay Bridge. The profile of the ramp leaving the terminal at the west end rises to meet the lower roadway of the Bridge. The CalTrain extension needs to cross over Howard Street, as the present ramp does, but then descend into a subway below Folsom Street. The CalTrain profile consequently has a hump, or crest vertical curve, in the vicinity of Howard Street. This profile is undesirable for train operations. Alternative profiles which reduce or eliminate this hump would require that Howard Street be lowered by several feet under the CalTrain overpass. The lowering of Howard Street would create impacts on the adjoining properties. Neither solution, the crest vertical curve for CalTrain or the lowering of Howard Street, appears desirable.

This situation would be minimized or eliminated with a new terminal on the existing site, because the train platform level could be raised, allowing the CalTrain profile to match the platform level without a hump. A higher platform level would also reduce the darkened tunnel effect of the terminal building crossings over Fremont, First and Beale Streets, and would allow higher ceilings at the ground and mezzanine levels of the terminal.

5. DRAWINGS

Drawings referred to in this report are from the Transbay Transit Terminal Renovation Project prepared by the California Office of the State Architect. These drawings have been marked to show the additional work required for the conversion of the Transbay terminal for the combined CalTrain and bus terminal. The following drawings are available for review at the JPB offices.

Drawing Number	Drawing Title
5.1	Typical Cross Section
1	Basement level Plan
2	First Floor Plan
3	Second Level Plan